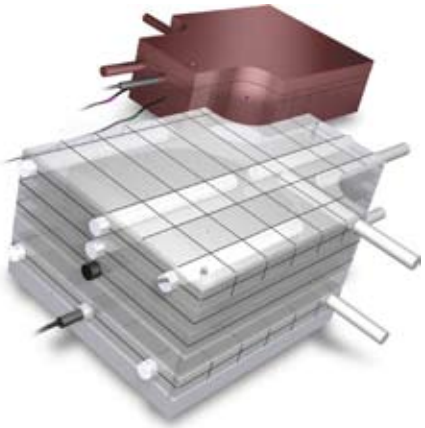

IMRT DOSE VERIFICATION PHANTOM

REF 91230 / 91235

STANDARD IMAGING, INC.
7601 Murphy Drive
Middleton, WI 53562-2532

TEL 800.261.4446
TEL 608.831.0025
FAX 608.831.2202

DOC #80336-07

STANDARD IMAGING.

General Precautions

WARNING:
Follow manufacturer's recommended safety procedures for radioactive sources.

CAUTION:
Do not drop or mishandle the slabs.

CAUTION:
Refer all servicing to qualified individuals.

CAUTION:
Proper use of this device depends on careful reading of all instructions and labels.

Warnings and Cautions alert users to dangerous conditions that can occur if instructions in the manual are not obeyed. Warnings are conditions that can cause injury to the operator, while Cautions can cause damage to the equipment.

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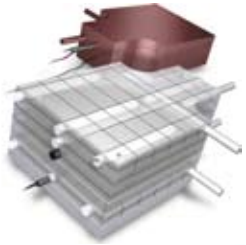

STANDARD IMAGING

7601 MURPHY DRIVE
MIDDLETON, WI 53562-2532 USA
WWW.STANDARDIMAGING.COM

Overview

The IMRT Dose Verification Phantom is designed to provide feedback on complex treatment plans generated using 3D. This phantom is especially applicable to IMRT and tomotherapy modalities. The phantom is designed to mimic a human torso. Multiple thicknesses allow measurements for different body sizes. Both film and ion chambers can be simultaneously irradiated for comparisons with the treatment planning system.

General Operation

The IMRT Dose Verification Phantom is easily used for dose verification by the following steps:

1. Select appropriate phantom configuration to resemble the clinical patient setup desired.

The provided location pins can be used by inserting the pins, larger diameter down, into the hole in the top surface of each phantom slice. Each slice has mating holes in the bottom surface to accept the protruding pins and lock the pieces together.

Each 3 cm acrylic or Virtual Water slice can be added for a total thickness range of 3 to 18 cm. Two pieces are solid and are placed in position where no data is to be collected. Two of the pieces have a cavity resembling the shape of a lung and are to be used when a large tissue inhomogeneity may present a complication in a treatment. The final two pieces contain a number of cavities for an ionization chamber. The ion chamber can be positioned anywhere along the cavity. Unused cavities are filled with the solid acrylic or Virtual Water rods. For commonly treated cases such as prostate, it is best to use a specified location for the chamber center as indicated by the scribe line. Place the lung inserts (set of four) into the simulated lung cavities and the bone equivalent plug into one of the ion chamber cavities, if desired.

2. Scan the Phantom setup with CT.

Arrange the assembled IMRT Dose Verification Phantom on the CT table with the ion chamber in position. Scan as much of the

phantom as possible ensuring that the entire length of the active area of the chamber is included. Export the scanned phantom to the treatment planning system and proceed to contour the active area of the chamber.

3. Position the phantom on the treatment unit.

Position the assembled IMRT Dose Verification Phantom on the treatment table placing isocenter in the middle of the desired chamber volume. The semitransparent acrylic version of the IMRT Dose Verification Phantom or is ideal for localization as the surface SSD may be easily read and at the same time the exact location of the chamber may be viewed with respect to the localization lasers. The scribe marks on the side of the phantom can be used for rapid isocenter placement. Place a piece of ready pack V type film at the appropriate level(s) where a coronal dose distribution is to be measured.

4. Import the fluence pattern from the original treatment plan on the computer.

For most planning systems that use dynamic multileaf collimators this is a standard feature and will copy the exact fluence pattern from one field to another. After each fluence pattern is copied onto the phantom plan, calculate the dose. If dose to a particular point off the central axis is desired, then a separate contour will be needed and can be placed inside one of the cavities. Next, place fields around the phantom in the same manner they were used in the patient plan. This involves selecting the fields with the same gantry, collimator and jaw settings.

Dose distributions on the phantom can be measured by placing a piece of ready pack verification film between the acrylic or Virtual Water slabs. If a high degree of correlation is desired, a small steel ball may be inserted in one of the cavities to provide a point of reference. The absolute dose to the chamber center may be calculated using the dose volume histogram utility available on most planning systems. If no such utility is available, the average dose may be computed by simply measuring the point dose on the planning system with a number of points and taking the average. If the dose volume histogram does not show a steep gradient at the expected dose level, then the chamber is either too big for the given field or in a region where the dose is changing rapidly and should not be used for an absolute measurement. If the exact location of the steel spheres is desired, make certain the film is pre-irradiated using an open field that covers the steel localization spheres embedded in the phantom. Pre-irradiation is acceptable since the film will only be used to show relative dose, not absolute dose. If one desires to have no irradiation in the area of the film to be analyzed, then simply pre-irradiate the film using two exposures with the jaws collimated up such that only a thin strip approximately 1 cm wide is used to irradiate the section with the steel spheres.

5. Irradiate the phantom

Irradiate the phantom delivering the dose just as one would if a patient were on the treatment table. Deliver approximately 50 cGy to the chamber. This will allow simultaneous irradiation of the chamber and film with the same beams. As the charge is accumulating on the chamber for each field, record the amount of charge accrued for each beam if possible. This is useful if a significant deviation is found between the measured and expected dose.

6. Compare results from phantom dosimetry with the original plan.

Using the appropriate calibration factors, convert the accumulated charge into an effective dose. If you are using the acrylic version of the IMRT Dose Verification Phantom, this conversion is done via the TG 21 protocol using the correction factors for an acrylic phantom. To assist with this task, Table 1 provides correction factors that include all the corrections needed to be applied to acrylic phantom readings to convert to the equivalent doses in water.

Example (see TG 21 for definitions of terms): Using data measured for a given field at a depth of 10 cm:

M = 2.13
nC = Measured charge for a given monitor setting
$\mathbf{P_{repl}}$ = 1.000
$\mathbf{N_{gas}}$ =4.663 x 10^9
L/r = 1.063
$\mathbf{P_{T,P}}$ = 1.022
$\mathbf{P_{ion}}$ =1.000
$\mathbf{P_{phan}}$ = See Table 1

NOTE: For the Virtual Water version of the IMRT Dose Verification Phantom, P_{phan} always equals 1.000.

Use the equation:

Dose in water (D_w) =

$$\mathbf{M * N_{gas} * L/r * P_{T,P} * P_{repl} * P_{ion} * P_{phan}}$$

Dose in water (D_w) =

2.13 * 4.663 * 1.063 * 1.022 * 1.000 * 1.000 * 1.034

D_w= 11.16 cGy for the acrylic version of the IMRT Dose Verification, where P_{phan} is given in Table 1 for 6X at 10 cm deep, and **D_w= 10.79 cGy** for the Virtual Water version as P_{phan} is always 1.000.

Table 1 is a ratio of charge measured in water to charge measured in acrylic at the same depth for a given number of monitor units. If your machine is not a 6X or 18X then you will need to measure these values or use the TG 21 procedure. The ratio in Table 1 is for a 10 x 10 cm reference field. The dependence of this ratio on field size is a second order effect which is estimated to be less than 0.5%, and can thus be neglected.

Develop the film and scan using film dosimetry software. The film may indicate a maximum dose that is higher or lower than what is given on the plan by up to 20% based on variations of film, temperature, processor conditions, etc. This deviation should not present a problem since the relative dose distribution on film compared with the treatment plan is of interest. Once the film is digitized, compare the location of selected isodose lines with that from the planning system. Any significant deviation should be investigated.

7. Other measurements

Point doses can be measured off axis using the optional TLD/Diode/MOSFET Phantom, REF 70608. If a point dose such as spinal cord is needed this can be accomplished by inserting the TLD/Diode/MOSFET Phantom in the approximate position above or below the desired isocenter. Once the exact location is determined from the patient plan, a small lead marker may be placed into one of the multiple slots and taped in place. The lead marker will appear when the phantom is scanned by the CT and the image imported into the planning system. A diode dosimeter or TLD may be placed in the location and irradiated along with the film and chamber. This will give an accurate point dose in a high gradient region without affecting the overall measurement.

Depth in cm	6X Correction Factor, P_{phant}	18X Correction Factor, P_{phant}
1.50	0.996	N/A
2.00	0.998	N/A
3.00	1.003	N/A
3.50	1.005	1.003
4.00	1.007	1.004
5.00	1.012	1.008
6.00	1.016	1.011
7.00	1.020	1.014
8.00	1.025	1.017
9.00	1.029	1.020
10.00	1.034	1.023
11.00	1.038	1.026
12.00	1.043	1.029
13.00	1.047	1.032
14.00	1.051	1.035
15.00	1.056	1.038
16.00	1.060	1.041
17.00	1.065	1.044
18.00	1.069	1.046
19.00	1.074	1.049
20.00	1.078	1.051
21.00	1.082	1.054
22.00	1.087	1.057
23.00	1.091	1.059
24.00	1.096	1.062
25.00	1.100	1.064

Table 1 Values of P_{phant} for 6X and 18X photons for various depths for a 10 cm X 10 cm field.

Recommended Exradin Ionization Chambers

General Chamber Specifications

For informational purposes, the specifications for most chambers useful for this application are given below.

Humidity: 30-70%, non-condensing
Temperature: 15 to 35° C
Pressure: 650 - 770 mm Hg
Nominal Collection Efficiency: 100%
Maximum Polarizing Potential: 1000 V
Normal Polarizing Potential: 300V

The Exradin chamber models given in the table below are normally used for IMRT applications. The specifications for each chamber are listed below.

Nominal Leakage Currents: 10^{-15} A
Cable: 50 Ω, 29 pF/ft, 1.5 m long
Connector: Triaxial BNC Plug, 2-Lug Male (shell of chamber is common with connector body)

Model	A1	A1SL	A14	A14SL	A12	A12S	A16
Collecting Volume (cm^3)	0.056	0.056	0.009	0.009	0.65	0.25	0.007
Nominal Calibration Factor (R/nC)	60	60	365	365	5	14	400
Centroid of Collecting Volume (mm from tip of chamber)	4.0	4.1	2.0	2.1	12.9	5.8	1.0
Collector Diameter (mm)	1.0	1.0	1.5	1.5	1.0	1.0	0.3
Outside Diameter of Shell Collecting Volume (mm)	6.0	6.25	6.0	6.25	7.1	7.1	3.4
Wall Thickness (mm)	1.0	1.1	1.0	1.1	0.5	0.5	0.5
Shell, Collector,& Guard Material	C552	C552	C552	C552	C552	C552	C552

Model Specifications

Using the IMRT Phantom Lung Tumor Insert

The optional IMRT Phantom Lung Tumor Insert (REF 70170) with cross hairs allows positional verification of treatment from simulation to radiation delivery. The insert is visible with kV and MV imaging techniques to allow comparison of treatment images with DRRs for 2D-2D matching, and comparison of cone-beam CT with simulation CT for 3D-3D matching.

This positional verification using the lung inserts can be important for use with the Respiratory Gating Platform to ensure that the imaging of moving objects, and radiation delivery to these objects, occurs as planned.

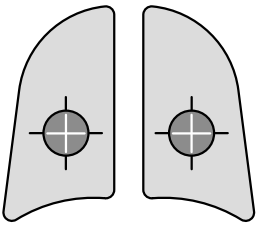

Diagram of two Lung Tumor Inserts aligned correctly within accompanying lung phantom slabs.

Maintenance

Exterior cleaning of the device can be done with a soft brush and a cloth. Gently brush all surfaces to remove dirt and dust. Remove any remaining dirt with a cloth slightly dampened with a solution of mild detergent and water or a liquid disinfecting agent.

There are no user serviceable parts on the IMRT Dose Verification Phantom. Calibration of the IMRT Dose Verification Phantom is not required.

If assistance is desired in the proper disposal of this product (including accessories and components), after its useful life, please return to Standard Imaging.

Parts and Accessories List

REF	Description
91230	IMRT Dose Verification Phantom (Acrylic Version)
91235	IMRT Dose Verification Phantom (Virtual Water Version)
80336	User's Manual
70608	TLD/Diode/MOSFET Acrylic Phantom Slab
72183	TLD/Diode/MOSFET Virtual Water Phantom Slab
50062	Additional Acrylic Phantom Slab
50068	Additional Virtual Water Slab
30613	Additional Solid Acrylic Plugs
30728	Additional Solid Virtual Water Plugs
Custom	Custom cavity drilled in 30613/30728 for any Ion Chamber
70611	Exradin A1/A14 plug
70615	Exradin A1SL/A14SL plug
70612	Exradin A12 plug
70613	Phantom PR-06 Farmer Chamber
70614	PTW 3000 series plug
92705	A1 Exradin Miniature Shonka Thimble Chamber, 0.056 cc
92722	A1 Exradin Slim Line Miniature Shonka Thimble Chamber, 0.056 cc
92711	A14 Exradin MicroChamber, 0.009cc
92723	A14 Exradin Slim Line MicroChamber, 0.009cc
92700	A12 Exradin Waterproof Farmer Type Chamber, 0.6 cc
32010	Location Pins
70170	IMRT Phantom Lung Tumor Insert (Optional)

Contact Standard Imaging for a variety of Custom Plugs available.

Bibliography

1. "A protocol for the determination of absorbed dose from high energy photon and electron beam." TG21 Med. Phys 10:(6) 741-771 (1983)

Table 1 courtesy of John Kordomenous, Ph.D., Advanced Radiotherapy Consulting, South Bend, IN.

Features and Specifications

Dimensions:

Height (six slabs)	18.00 cm (7.09 in.)
Width (each slab)	30.00 cm (11.81 in.)
Length (each slab)	45.00 cm (17.72 in.)

Weight (six slabs) 22.7 kg (50.0 lbs.)

Individual Components:

(2) Acrylic/Virtual Water Chamber Phantom Slab with 6 cavities for Ion Chamber placement
(2) Acrylic/Virtual Water Phantom Slabs for build up thickness
(2) Acrylic/Virtual Water Lung Phantom Slabs with cavities for simulated lungs
(16) Solid Acrylic/Virtual Water Plugs to fill unused Ion Chamber cavities
(1) Solid Acrylic/Virtual Water Plug with cavity for Chamber of your choice
(1) Bone Equivalent Plug
(1) Lung equivalent insert set to fill lung phantom voids
(12) Location Pins

Specifications are subject to change without notice.

Notes

Notes

Service Policy

If service, including recalibration, is required, please contact Standard Imaging's Customer Service department by phone or email prior to shipping the product. Standard Imaging's Customer Service and Technical Service staff will attempt to address the product issue via phone or email. If unable to address the issue, a return material authorization (RMA) number will be issued. With the RMA number, the product can be returned to Standard Imaging. It is the responsibility of the customer to properly package, insure and ship the product, with the RMA number clearly identified on the outside of the package. The customer must immediately file a claim with their carrier for any shipping damage or lost shipments. Return shipping and insurance is to be pre-paid or billed to the customer, and the customer may request a specific shipper. Items found to be out of warranty are subject to a minimum service fee of 1 hour labor (excluding recalibrations) for diagnostic efforts and require a purchase order (PO) before service is performed. With concurrence from customer, the product may be replaced if it is unserviceable or if the required service is cost prohibitive. Products incurring service charges may be held for payment. Standard Imaging does not provide loaner products. See the Standard Imaging Warranty and Customer Responsibility for additional information.

Serialization Information

Standard Imaging products that are serialized contain coded logic in the serial number which indicates the product, day and year of manufacture, and a sequential unit number for identification:

A YY DDD X

A Unique product ID
YY Last two digits of the year (e.g. 1999 = 99, 2000 = 00)
DDD Day of the year (1≤ DDD ≤ 365)
X Unique unit ID Number (1 ≤ X ≤ 9)

Customer Responsibility

This product and its components will perform properly and reliably only when operated and maintained in accordance with the instructions contained in this manual and accompanying labels. A defective device should not be used. Parts which may be broken or missing or are clearly worn, distorted or contaminated should be replaced immediately with genuine replacement parts manufactured by or made available from Standard Imaging Inc.

⚠ **CAUTION: Federal law in the U.S.A. and Canadian law restrict the sale, distribution, or use of this product to, by, or on the order of a licensed medical practitioner. The use of this product should be restricted to the supervision of a qualified medical physicist. Measurement of high activity radioactive sources is potentially hazardous and should be performed by qualified personnel.**

Should repair or replacement of this product become necessary after the warranty period, the customer should seek advice from Standard Imaging Inc. prior to such repair or replacement. If this product is in need of repair, it should not be used until all repairs have been made and the product is functioning properly and ready for use. After repair, the product may need to be calibrated. The owner of this product has sole responsibility for any malfunction resulting from abuse, improper use or maintenance, or repair by anyone other than Standard Imaging Inc.

Warranty

Standard Imaging, Inc. sells this product under the warranty herein set forth. The warranty is extended only to the buyer purchasing the product directly from Standard Imaging, Inc. or as a new product from an authorized dealer or distributor of Standard Imaging, Inc.

For a period provided in the table below from the date of original delivery to the purchaser or a distributor, this Standard Imaging, Inc. product, provided in the table is warranted against functional defects in design, materials and workmanship, provided it is properly operated under conditions of normal use, and that repairs and replacements are made in accordance herewith. The foregoing warranty shall not apply to normal wear and tear, or if the product has been altered, disassembled or repaired other than by Standard Imaging, Inc. or if the product has been subject to abuse, misuse, negligence or accident.

Product	Warranty Period
Standard Imaging Ionization Chambers	2 years
Standard Imaging Well Chambers	2 years
Standard Imaging Electrometers	2 years
Standard Imaging BeamChecker Products	2 years
Standard Imaging Software Products	1 year
All Other Standard Imaging Products	1 year
Standard Imaging Custom Products	1 year
Standard Imaging Remanufactured Products	180 days
Standard Imaging Custom Select Products	90 days
Consumables	90 days
Serviced Product	90 days
Resale Products	As defined by the Original Equipment Manufacturer
ADCL Product Calibration (Standard Imaging uses the UW-ADCL for recalibrations required under warranty)	0 - 90 days = 100% of ADCL Calibration Costs 91 - 182 days = 75% of ADCL Calibration Costs 183 – 365 days = 50% of ADCL Calibration Costs 366 – 639 days = 25% of ADCL Calibration Costs (days from date of shipment to customer)

Standard Imaging's sole and exclusive obligation and the purchaser's sole and exclusive remedy under the above warranties are, at Standard Imaging's option, limited to repairing, replacing free of charge or revising labeling and manual content on, a product: (1) which contains a defect covered by the above warranties; (2) which are reported to Standard Imaging, Inc. not later than seven (7) days after the expiration date of the warranty period in the table; (3) which are returned to Standard Imaging, Inc. promptly after discovery of the defect; and (4) which are found to be defective upon examination by Standard Imaging Inc. Transportation related charges, (including, but not limited to shipping, customs, tariffs, taxes, and brokerage fees) to Standard Imaging are the buyer's responsibility. This warranty extends to every part of the product except consumables (fuses, batteries, or glass breakage). Standard Imaging, Inc. shall not be otherwise liable for any damages, including but not limited to, incidental damages, consequential damages, or special damages. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

This warranty is in lieu of all other warranties, express or implied, whether statutory or otherwise, including any implied warranty of fitness for a particular purpose. In no event shall Standard Imaging, Inc. be liable for any incidental or consequential damages resulting from the use, misuse or abuse of the product or caused by any defect, failure or malfunction of the product, whether a claim of such damages is based upon the warranty, contract, negligence, or otherwise.

This warranty represents the current standard warranty of Standard Imaging, Inc. Please refer to the labeling or instruction manual of your Standard Imaging, Inc. product or the Standard Imaging, Inc. web page for any warranty conditions unique to the product.